IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	A.N. Neogi et al.	Attorney Docket No.:	WEYE120773/25194
Application No.:	10/602,208	Art Unit:	1773 / Confirmation No: 2234
Filed:	June 23, 2003	Examiner:	L.B. Kiliman
Title:	METHODS FOR ESTERIFYING HYDROXYL GROUPS IN WOOD		

DECLARATION UNDER 37 C.F.R. § 1.132

Federal Way, Washington 98063

June 29, 2006

TO THE COMMISSIONER FOR PATENTS:

I, Gary D. Peterson, hereby state:

1. I am a co-inventor of the subject matter described and claimed in the above-identified patent application.

2. I am a research process engineer at Weyerhaeuser Company (hereinafter referred to as "Weyerhaeuser"), assignee of the patent application.

3. For the last 29 years, I have worked for Weyerhaeuser, researching in areas including, pulp, paper, fluff and projects related to wood modification.

4. During this time, I have worked with the concept of esterifying hydroxyl groups in wood at the Weyerhaeuser Company.

5. I have carefully reviewed and considered the patent application, including the claims.

7. Typical microwave frequencies used by the industry for heating include 915 MHz and 2450 MHz.

8. Calculations were carried out to determine how effective heating at these frequencies would be.

9. These calculations for the penetration depth of the energy used the public domain electrical data for lumber loaded with acetic anhydride and heated with 2450 MHz microwave power given below:

Pine wood/ acetic anhydride loaded material at a microwave frequency of 2450 MHz:

Temperature (C)	dielectric constant (e')	dielectric loss factor (e")
40	14	1
100	10	0.6

10. This public data was used to calculate the penetration depth of the microwave power into the product. (See reference Industrial Microwave heating by A.C. Metaxas and R.J. Meredith page 80 equation 4.31 for the theory.)

11. These calculations suggested that the penetration depth at this microwave frequency was limited to about 3 to 4 inches.

12. This will likely give sufficient heating uniformity in a product that has one of more dimensions less than 6 to 8 inches.

13. This is practical for processing individual pieces of lumber or pieces stacked with significant spacers between them.

14. The processing of small loads is not economical for the lumber industry.

15. Lumber closely stacked in large commercial loads (48"x48"x16 feet) is needed to make the process economically viable.

16. The use of 2450 MHz energy will result in poor heating uniformity and subsequent poor product quality.

17. A further calculation at 915 MHz demonstrated that it too was insufficient for uniform heating.

18. Since microwave power equipment for industrial heating is limited mainly to 2450 and 915 MHz, it appeared that the microwave heating of large commercial acetylation products/loads is not practical.

19. In addition, heating at a frequency of 300 MHz or less was not taught in the art for the following reasons:

a. Increased chance of arcing at low frequencies – causing excessive downtime.

b. Difficulty in finding energy sources having a reasonable capital cost and are also reliable and controllable.

c. Difficulty in computing heating patterns and electric field strength.

d. Difficulty in achieving high electrical efficiency and low operation cost.

20. Experimental work was then carried out by myself and other Weyerhaeuser employees on or about September 2003 to measure the electrical properties (dielectric constant and loss factor) for wood loaded with acetic anhydride in the frequency range of 5-10 MHz – well below the microwave frequency range.

21. These values are not in the public domain, but were needed to compute the energy penetration for at these low frequencies.

22. A summary of these experimental measurements is given in the table below:

MATERIAL	DIELECTRIC CONSTANT (e')	LOSS FACTOR (e")
1) Dry Loblolly Pine lumber	1.8 @ 4% MC 3.4 @ 16%MC	0.1 @ 4%MC 0.3 @ 16%MC
2) Dry Loblolly Pine impregnated with acetic anhydride solution.	3.4 to 5.2	0.23 to 1.31
Note: Results depend on solution concentration and temperature. Dielectric loss factor increased significantly with temperature.		
Special test: 67% acetic acid and 33% acetic anhydride	3.45-3.75	0.23-0.63
3) Dry Loblolly Pine impregnated with acetic acid solution.	3.7 to 18.0	2.3 to 7.4
Note: Results depend on solution concentration and temperature. When water was NOT present the loss factor was much lower (0.55-.70)		
4) Acetylated Loblolly Pine	1.6@ 0%MC 1.7@ 3%MC	0.037 @0%MC 0.055 @3%MC

23. The calculated penetration depth was estimated from this data to be well over 200 inches at 30 MHz or less.

24. As a result it was discovered that the heating uniformity for large loads (4'x4'x16 feet) appeared acceptable for a frequency less than 30 MHz.

25. This discovery meant that microwave frequencies (over 300 MHz) would not be acceptable for heating large loads, but the lower RF frequencies of 3 to 30 MHz would be acceptable.

26. In addition, it was believed that the lumber load would have to be restrained during the drying stage to prevent product degrade.

27. This meant the metal electrodes needed for the low frequency heating system would have the added benefit of restraining the lumber and preventing bowing, etc. during the process.

28. This is a further advantage over the microwave heating system since metal near the load at microwave frequencies normally reduces the heating in that area and contributes to poor heating uniformity and product degrade.

29. Moreover, heating in this frequency range was not obvious for large wood load acetylation to one skilled in the art of dielectric heating.

30. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

DATE: 6/29/06

Gary D. Peterson